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Status of Arab Nuclear Potential

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STATUS OF ARAB NUCLEAR POTENTIAL

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[Article by Dr 'Adnan Mustafa, Assistant Secretary General of OAPEC [Organization of Arab Petroleum Exporting Countries: "Situation of Arab Nuclear Potential"]

[Text] This report is concerned with describing and analyzing the current Arab approaches in the sphere of nuclear technology--approaches through which significant nuclear activities are proceeding. Our research has been aimed principally at realizing two things: First, reflect a picture of the situation of the Arab nuclear potential and, second, evaluate the Arab aspiration for the acquisition of nuclear technology. In doing this we have proceeded from the starting point of focusing attention on the current works seeking to employ [tatwi'] nuclear technology in some Arab countries. Our report consists of a review of the process of the introduction of nuclear technology to the Arab homeland and an analysis of the situation of the Arab nuclear potential, along with a conclusion and proposals.

To familiarize ourselves with the (confidential) facts available on the nuclear technology in the Arab homeland, we have exerted major efforts, including short visits to Arab countries that we had selected (such as Algeria, Jordan, Lebanon, Mauritania, Morocco, Syria and Tunisia), interviews with a select group of Arab scientists and politicians concerned with energy issues and then a sifting of the facts we have collected through a questionnaire that we sent to most of the Arab countries. As a result, we have acquired comprehensive expert opinions and varying evidence on the issues of uranium exploration and mining, nuclear fuel cycle, reactor technology and nuclear manpower and management in the Arab states.

In its capacity as the first research on the Arab nuclear potential, this work of ours can be considered a starting point for serious research and discussions on the potentials of the common Arab action that must exist to enhance the Arab nation's acquisition of nuclear technology and, then, to build a bright future for the Arab nuclear energy (1).

Introduction of Nuclear Technology to Arab Homeland

The tension existing between the special interests of the advanced countries and the basic needs of the developing countries and between the principles of subservience and independence (2) appears clearly in every aspect of the process of employing technology (such as the prices of the technology, the restrictions on the transfer of the technology and the obstacles obstructing the realization of a better understanding during the process of the transfer of the technology). On the one hand, the advanced countries feel that they should get appropriate returns for their investments in technological research and development. On the other hand, the developing countries feel that they pay more than they should for an old technology supplied to them in an inadequate manner by the advanced countries. The tension reaches its peak in the case of transfer of the nuclear technology--a sphere in which the feelings turn into feelings of anger as a result of:

1. The awareness among the advanced and nuclearly superior countries of the direct relationship between nuclear energy and nuclear weapons. Because of this relationship, the advanced countries feel that a threat to world security can emanate from the aspiration of others to realize self-sufficiency in the nuclear sphere. The aforementioned awareness has been reflected in ever-increasing restrictions imposed on the technology transfer process. This has aroused the wrath of the advanced countries lagging behind in the nuclear sphere and the wrath of the developing countries (4).

2. At present, nuclear energy is considered the sole visible and possible alternative to the conventional energy resources required to meet the economic development energy needs (graph 1). This fact has been reinforced "as a result of the constant depletion of mined fuels by the advanced countries and by the lack of effective measures taken to preserve these resources which are considered the property of all mankind. Add to this that the third world, which comprises two thirds mankind, must get its share of these resources at present and in the future (5)." As a result of the response of the advanced countries that are not superior in the nuclear sphere to the latter demand, some developing countries, such as Bangladesh, Brazil, India, Pakistan and Turkey, have been able to start national nuclear programs. But the atomically advanced countries have not hesitated to counter the good initiative of the other advanced countries by forming the London Nuclear Club.

3. With the presence of almost total monopolization of the uranium enrichment process by the atomically advanced countries. the other advanced countries are experiencing an increasing concern in proportion with the emergence of new restrictions on the enrichment technology.

International Trends for Employment of Nuclear Technology

With the end of the period of confidentiality over nuclear energy secrets in 1958, the nuclear technology entered a phase of openness. This phase was followed by a phase of rectification [tamhis] (6). During the latter two phases, the process of mastering the nuclear technology--within the advanced countries--made vast strides of progress. These steps resulted from: 1. Disappearance of the uranium monopoly. 2. The growth in the nuclear energy installations commerce. 3. The availability of enriched uranium from the United States. 4. Nuclear control which has become one of the fundamental characteristics of any nuclear cooperation among the advanced countries.

As for the processes of mastering the nuclear technology in the advanced countries, they have proceeded through the following bridges in accordance with European and international commitments: 1. Theoretical nuclear research. 2. Dialogue among the nuclear experts. 3. Mutual training of skilled manpower. 4. The establishment of international agencies (such as the Atomic Energy Agency) which have contributed to expanding the exchange of nuclear expertise. 5. The establishment of multinational nuclear projects. Because of the almost complete monopolization of the uranium enrichment process, this process remained unchanged and, consequently, became one of the most prominent aspects of struggle in the nuclear technology. In 1967, a group of (uratum and foratum) experts called for "liberating Europe from its total subservience to the United States insofar as supplying the nuclear installations with enriched uranium is concerned." (7) In the wake of this call, the governments of Britain, West Germany and the Netherlands concluded the (Almilo) treaty with the aim of setting up some means of uranium enrichment. But the results of this treaty did not appear until last year when two experimental models were inaugurated in each of (Cabinhurst), Britain, and Almilo, in the Netherlands. (8)

Numerous developing countries have tried to master the nuclear technology through the various phases of their national development but have not had success because their chances of success are tied to the following conditions:

1. The degree of the openness of the world of nuclear politics. 2. The flexibility of these countries with the multinational establishments on the matter of the factors involved (i.e. the economic, political and social factors) on the one hand. 3. The presence, on the other hand, of a well-organized national nuclear program. 4. The availability of: A. Definite and independent national financing; B: The presence of a national nuclear organization capable of carrying out intrinsic initiatives and of realizing a clearcut program; C: An advanced supporting industrial base.(9)

The above described situation applies to the Arab homeland, considering that it faces along with other developing countries, a large number of obstacles that stand as a stumbling block against its possession of the nuclear technology. Most of the relatively advanced Arab countries suffer at present, in addition to their reliance on imported technology (10), from the absence of the national nuclear model, the lack of interest in planning for it, the predominance of indifference to nuclear energy and from the almost foggy activities pertaining to nuclear research and development.

In the early 1970's, the Arab homeland witnessed the rise of a new approach for the acquisition of nuclear technology. Algeria, Egypt, Tunisia and Morocco tried to define their long-range-programs in this sphere, discovered some of the major problems that may arise during the phase of mastery of the nuclear technology and thought of some national measures to solve these issues.

Some Arab Trends Concerning Transfer of Nuclear Technology

There is no doubt that the success realized by some developing countries in the sphere of mastering the nuclear technology has strongly affected the entire scientific and industrial progress in these countries (11). This has encouraged developing Arab countries to acquire the nuclear technology to meet their future need for a long-range energy source on the one hand and, consequently, to introduce a new means to enhance their technological progress (12). However, the success of a national nuclear program is closely linked to several fundamental requirements. The most important of these requirements is to create a national nuclear development organization, considering that such an organization has proven its usefulness in the developing countries that have entered the sphere of nuclear activity. After being entrusted with the responsiblity of developing the national nuclear programs, each of the Nuclear Technology and Sciences Center in Algeria, the Nuclear Energy Organization Authority in Egypt, the Nuclear Energy Organization in Iraq and the similar organization in Libya are using in an ideal manner all the nuclear means available in these countries with the aim of enhancing national awareness of the nuclear technology on the one hand and of creating this technology's national base on the other (13).

There are three other requirements that must be realized to enhance the process of mastering the nuclear technology:

First, to achieve maximum benefit from the mastery process, the scientific and technological manpower in the countries receiving the technology must be capable of absorbing the main features of the nuclear energy. Moreover, the ability of this manpower should be enough to enable it to overcome the numerous complications that accompany the use of this technology. The available data in this regard indicates that the Arab homeland possesses limited manpower in this sphere (14). In the Arab countries concerned with nuclear energy, there is a predominant belief in the need for them to : 1 - Urge scientists and technicians to support this national action; 2 - Build the substructure that helps training; 3 - Review and develop all the national activities in the sphere of higher education in particular and of research and development generally.

Second, participation by the national industry in establishing a heavy nuclear industry must be as big as possible. The Arab states that have laid down the beginnings of heavy industries, such as Algeria, Iraq, Egypt and Saudi Arabia, may be able to meet this demand and to make it more available in the 1980's.

Third, public opinion acceptance of the nuclear technology can be considered one of the main issues governing this technology. Nuclear performance, the availability of nuclear fuel, nuclear safety, nuclear protection standards and the treatment of nuclear wastes are major issues raised by the public opinion in the face of any nuclear program (15). As a result of the relatively widespread use of nuclear energy for peaceful purposes in the Arab homeland, the Arabs feel general satisfaction with this energy. What concerns them is the rapid spread of the nuclear weapons arsenal in the advanced countries. It is worth noting that the background for this concern is still vague (16).

Throughout the past three generations, the nuclear technology has been applied more and more extensively in our scientific and technological world. Various peaceful nuclear technologies have been used in the food industry, in livestock production, in medicine, agriculture, irrigation, industry and the environment (17). The Arab world has benefited from this amicable international tendency and has devoted considerable efforts to acquire and use the peaceful nuclear technologies. The establishment of the Arab Mideastern Regional Isotopes Center in 1963 denotes the realization of the common Arab step to master the peaceful nuclear technology (18)&(19).

The availability and the price of uranium will continue to have a major impact on nuclear energy. By the end of 1977, the studies on these two sensitive issues reached the following conclusions:

1. The international prices of uranium ready to deliver immediately responded to the marketing factors and to the production costs by rising from $39 per kilogram in 1974 to nearly $54 per kilogram in the middle of 1975 and settled relatively at $104 per kilogram in 1977 (20).

2. The international nuclear energy expectations indicate the possibility of a rapid increase that may amount to 277 (gayfawatts) in 1980 and 483.1 gayfawatts in 1985 (21). This will reflect in depleting [ijhaz 'ala] the known or likely uranium resources falling within the category of $201 per kilogram during the period before 1980. The uranium resources within the category of $30 per kilogram will also be depleted by 1985 (charts 1 & 2).

As a result of these two facts, an urgent international desire has been generated to expand the exploration and exploitation of uranium found in combination with other primary resources, such as phosphate. This desire has reached the heart of the Arab homeland where it has been embodied in the form of exploration programs and mining activities in some parts of the Arab homeland (23). Moreover, the interest in extracting uranium as a byproduct in the phosphate fertilizers industry has begun to emerge in the form of the Arab studies and political and economic agreements concluded with a number of advanced friendly countries.

Chart No 3 shows that the Arab phosphate fertilizers industry will undergo an increase of 167 percent in its capacity with the onset of 1985 (26). Add to this the fact that: 1 - Only 4 kilograms of fertilizers are currently used per capita in the Arab agricultural activity in comparison to 74 kilograms, 49 kilograms and 84 kilograms used per capita in each of the United States, Europe and Australia successively; 2 - Only 15 percent of the Arab arable land is exploited currently. From the two abovementioned facts, it is evident to us that the fertilizer capacity increase rate in the Arab homeland may reach a different figure in the next decade. Consequently, we expect the emergence of a strong inclination to extract uranium from Arab phosphate.

2. Situation of Arab Nuclear Potential

Nuclear Energy and Arab Development Plans

Before the 1970's, a few Arab countries understood the effective role that nuclear energy can play in developing their national economy. Afterwards, Algeria, Egypt and Iraq focused their attention on some aspects of the heavy nuclear industry whereas the other Arab states continued to engage in activities connected with the peaceful aspects of the nuclear technology. It is worth noting that as a result of Iraq's, Algeria's and Egypt's engagement in diverse and advanced industrial activities, these countries have been able to create some links with the advanced technology. Algeria, for example, has opened with its advanced industries various channels through which it has supplied the Algerian economy with some high-quality basic industrial products that must be available to entrench its economic and technological independence. With this difficult economic policy, Algeria has proceeded to set up a nuclear industry. "Nuclear energy in Algeria must be built in the near future in a manner parallel to the serious exploitation of the known uranium mines." Algerian decree No 76 adds: "There is no doubt that setting up nuclear energy installations will prepare the path for the Algerian industry's nucleus to speed up its growth and to realize effective accomplishments in its technological development." (28)

In Egypt, organized programs have been prepared to expand Egypt's electric energy capacity so as to keep up with the increased energy consumption resulting from the rising population growth and from the assault of foreign capital on the Egyptian economy. As shown by graph No 2, it is expected that the nuclear energy installations will contribute nearly 25 percent of the expected total energy needs in 1985, 35 percent of these needs by 1990 and 39 percent by the end of the century (29). Preliminary studies conducted to determine the nuclear fuel requirements of the Egyptian nuclear energy projects indicate that these requirements--at the outset of the nuclear fuel cycle--range from 16,000-22,000 tons of uranium oxide by the year 2000. The cost of this quantity of fuel ranges from 7-9 billion U.S. dollars for light water reactors. But in case heavy water reactors are used, the volume of this fuel will range from 8,000-10,000 tons of uranium oxide costing 3.1 billion and 4.2 billion U.S. dollars successively (30). In case a program similar to the one formulated by Algeria is adopted, a financial investment amounting to the abovementioned costs can establish a comprehensive program for the nuclear fuel cycle in Egypt and can assure Egypt of definite partial supply for its nuclear projects (31).

There are large areas of semi-barren or barren lands covering most parts of the Arab homeland. Some of these areas have been blessed by nature with fresh surface water that can be exploited to turn a large part of them into arable lands. Other areas are adjacent to saline waters that can be turned into fresh water, as in the case of Kuwait, Saudi Arabia and Libya. Now that it has become evident in the Arab homeland that the Arab oil resources are depletable and that it has become a must for the Arabs to turn toward finding alternative future energy sources, it seems useful at this phase to think of Arab nuclear installations to distill [presumably meaning desalinate] saline water. It is a source of joy that this fact is taken into consideration in the development plans of the aforementioned countries and that the inclination of the Arab countries to set up nuclear desalination projects in the last two decades of this century is underlined (32).

The process of a serious transfer of the peaceful nuclear technology has been included in most of the Arab development plans. As a result, some prominent technological projects have been set up in the fields of agriculture, medicine, industry and the environment (33). The Arab Middle East Regional Isotopes Center has played an important role in spreading these technologies in the Arab homeland. The center was set up at the outset of 1963 to realize: 1 - Specialized training in the applications of isotopes, especially in the spheres of agriculture, irrigation, medicine, industry, physical health and protection against radiation; 2 - Conduct some nuclear research to study surface waters, the diseases of the hot areas, fertilizers and the environment; 3 - Enchance the isotopes technology in the Arab countries.

Current Arab Studies and Works Concerning Acquisition of Nuclear Technology

During the 1964 U.N. Trade and Development Conference, the developing countries were unanimous in expressing their concern over the gap separating their quality of life from the quality of life in the advanced countries. The chaos prevailing in the international economy and technology are the causes of the gap because, on the one hand, the advanced countries dominate all the world's natural resources and lead in all aspects of modern technology and, on the other hand, the developing countries are losing their most important natural resources for an unfair return.

Since oil prices were corrected in 1973, the developing countries have been gaining gradual recognition of their main demands, such as the principle of their sovereignty over their primary resources, "because the industrially advanced countries can no longer ignore the natural demands of the developing countries that call for a establishing a new international economic system." (34)

In any case, all that has been recognized so far does not mean that all the demands of the developing countries have received acceptance and does not mean that the economic and technological difficulties of these countries have been solved finally. These countries are still facing complex problems, such as:

1. The problem of stability in the prices of primary industrial products.

2. The problem of dealing with their accumulated debts which amounted to $130 billions by the end of 1975 (35).

3. The problem of mastering technology.

There is no doubt that the diverse complexity of the abovementioned third problem entails conflicts of varying degree between the supplier and the importer. Moreover, the intensity of the conflict varies from one situation to another. However, the conflict reaches its peak in the cases of the transfer of a complex technology, such as the nuclear technology. The transfer-of-technology process lives, for example, under the (threat) of the ghost of the London Nuclear Club's principles (36). In 1976, the said club declared, under the slogan of (preventing the proliferation of nuclear weapons), the main restrictions on the exportation of sensitive nuclear technology, namely:

1. The country exporting the nuclear technology has the duty of ascertaining that the technology, whatever its description, will not be used for manufacturing any nuclear explosive device for any purpose whatsoever (37), not even peaceful nuclear explosives designed for land control.

2. The country exporting the nuclear technology must demand guarantees that the imported technology will be safeguarded against the risks of theft and sabotage (38).

3. The country importing the nuclear technology must give guarantees that the transferred technology will continue to be subject to the international nuclear restrictions for a period of 20 years.

Even some of the less advanced countries in the sphere of nuclear technology are expressing anger these days toward the more advanced countries because they believe that the (rich) are becoming fanatic to humiliate the (poor). At the Salzburg international conference on "nuclear technology and its fuel cycle--1977," Assistant U.S. Secretary [not further identified] Nay parted the black curtain a little when he began to explain President Carter's plan for nuclear energy. Nay stated that the United States has banned treating nuclear wastes inside the United States (39) and that permits for treating these wastes must be issued separately and when the need arises. It is obvious from this that the treatment agreements for 10 or 15 years--agreements that form the base for financial investment in the treatment installations--will be threatened (40). Opposition to the abovementioned policy emerged in the

1977 Iran conference on mastering the nuclear technology when representatives of the developing countries expressed their concern vis-a-vis the increased restrictions and shackles imposed on the transfer of nuclear technology.

In any case, it is not in the interest of the developing countries to enter the sphere of nuclear confrontations and continued such confrontation must be prevented. The developing countries have not yet had the chance to strengthen their defense positions and to build up their national nuclear capabilities. The cause of the inability to overcome this situation is due to lack of control over the process of mastering and developing the technology and because "for numerous reasons, the issue of controlling the process of mastering the technology has been neglected, thus leading to widening the technological gap and to the predominance of technological subservience in the developing countries."(41)

Like the other developing countries, the Arab countries' awareness of some facts of life has grown stronger. The Arab countries' awareness of the depletable nature of their mined fuel has, for example, opened their eyes to look for alternative sources to the conventional energy. This is why a man encounters more than one Arab primary energy policy and becomes aware of distinctive efforts to acquire the nuclear technology. We will find in this research an endeavor to outline the main features of such efforts throughout the Arab homeland and to underline a number of joint steps that may form the base for building a common Arab action.

The Arab policies concerning the acquisition of nuclear technology fall within two types:

The first type proceeds on the basis of the need to realize balanced and ever-wider steps to absorb and assimilate, and then to master, the successful aspects of the nuclear technology. The phased goal of this type of policies has been focused on acquiring some parts of the nuclear industry and this goal has been realized with varying degrees of success in each of Algeria, Egypt and Iraq. By following this difficult course, the three Arab countries have acquired a considerable amount of nuclear technology which encourages their aspirations to enter into the heart of the nuclear issue.

For this reason, we find that the development plans being currently implemented by these countries contain courageous nuclear energy policies.

The second type of policies embodies clearly the interest of those adopting these policies to keep up with the scientific aspects of the nuclear technology. The interest of this kind of policies has been focused on the isotope applications in the spheres of irrigation, agriculture, medicine, industry and the environment. In any case, it must be pointed out that this second type is suffering, in the current phase, from the guilt complex of keeping the Arab countries adopting such policies far from framework of the second [presumably meaning first] type of policies whereas Israel, the Arabs' number one enemy, has realized considerable success in nuclear industrialization (particularly nuclear weapons) by following the first type of policies.

Both types of Arab nuclear policies have been implemented through specialized agencies or through tasks carried out by the Arab ministries concerned, as demonstrated by chart No 4.

At the regional level, the Rabat declaration (CASTARAB 1976) (42) announced the start of the first phase on the path of Arab technological progress. The scattered recommendations and resolutions emanating from Arab energy meetings, conferences and seminars were revived in the form of detailed and specific recommendations in the aforementioned Rabat conference.

As for the nuclear technology, it seems useful to point out that the CASTARAB conference proposed (strongly) the establishment of three Arab nuclear centers in the center and the two flanks of the Arab homeland. These centers can devote attention to: 1 - Training; 2 - Research; 3 - Development of the nuclear technology. The conference proposed supplying each center with a 50-megawatt reactor, in addition to proposing the establishment of an Arab regional center for the nuclear fuel cycle through cooperation with the International Atomic Energy Agency (43).

Situation of Arab Homeland's Nuclear Potential

1. Exploration, Exploiting and Processing Uranium:

Exploring and exploiting uranium deposits is considered an acceptable national goal in some Arab countries. This goal derives its justification from the following considerations:

1. The new and ambitious Arab development plans require in inexhaustible source of energy, such as the nuclear energy (44).

2. To establish an independent nuclear capability, the Arab countries following the nuclear course must rely on their national resources to realize this goal.

3. At the international level, the need calls for contributing to the international efforts seeking to raise the world uranium reserve from its previous annual rate of 40,000 tons to 200,000-300,000 thousand tons in the early 1990's (45).

There is no doubt that the challenge facing the world uranium production industry is clear and that every effort possible must be made to improve the world uranium potential. Moreover, the Arabs cannot be excluded from this situation (46). On this premise, some Arab countries have exerted tangible efforts in prospecting for uranium and these efforts have led to definite knowledge concerning some abnormalities deserving attention in each of Morocco, Algeria and Somalia. Unless financing factors obstruct these efforts, they are expected to discover the presence of nearly 1.5 million tons of uranium oxide in the 1990's. This amount is equal to 167 percent of the world's certain uranium reserves at present (47 & 48). It doesn't seem to us to be late to arouse the interest of the Arab financing circles in this sphere. The opportunity is still wide open for these circles to move ahead for expanding Arab participation in the uranium production industry.

Most of the uranium deposits found in the Arab homeland and demonstrated in chart No 5 have been discovered by: A - Use of the geological data; B - Aerial surveys; C - Mobile ground surveys; D - Detailed ground surveys.

Moreover, exploratory wells have been drilled wherever reasonable deposits have been found and detailed surveys, tunnel drilling and deep drilling have also been carried out to evaluate the discovered uranium deposits. Chart No 5 demonstrates the percentage of uranium residues in Arab phosphate. Assuming that this residue amounts to an average percentage of 0.01 percent (49), then the Arab phosphate contains nearly 6 million tons of uranium oxide that can be extracted as a byproduct of the phosphate fertilizer industries (50).

Chart No 6 demonstrates the volume of uranium deposits in some parts of the Arab homeland (51). By comparing the Arab uranium resources with the estimated world resources, demonstrated in chart No 7, it seems interesting to say that the Arab uranium that can be extracted as a byproduct from phosphate amounts to nearly 57 percent of the same secondary production that can be extracted from the phosphate of the rest of the world, as demonstrated in chart No 8.

2. Nuclear Fuel Cycle:

A study on the current investment activities in uranium in the Arab homeland indicates that the investment process is still in its early stage. Algeria, Egypt and Iraq are exerting at present serious efforts to find ideal investment means compatible with their uranium environment and with the accompanying natural resources. Moreover, a pioneer and original research is being conducted at present by specialized departments in this sphere in each of the Nuclear Sciences and Technology Center in Algeria, the Atomic Energy Organization in Egypt and the Atomic Energy Organization in Iraq. It is worth noting that the Algerian nuclear center has been able to set up an integrated group of departments concerned with dealing with all issues pertaining to the nuclear fuel cycle.

As for the potentials of extracting uranium as a byproduct of the Arab phosphate fertilizers industry, this potential is the subject of concerted studies by the Arab nuclear authorities concerned. In this regard, the studies proceed in the direction of:

A. Extracting uranium as a byproduct through ventures proposed by the international mining and industry companies. B. Employing the currently available technologies (55).

It seems that Egypt, Jordan, Lebanon, Morocco and Syria are trying to follow the first course whereas Algeria and Iraq are inclined toward the second course (56 & 57).

3. Reactor Technology:

There are two facts that must be given careful consideration when analyzing the situation of the Arab reactors technology demonstrated in chart No 9. The first fact is that it is obvious that most of the Arab countries are consumers of the manufactured goods and of the technology developed by others. The availability or scarcity of the national technological and economic resources represents the second fact. In the light of these two facts, a person can distinguish three patterns through which the Arabs have proceeded to acquire by varying degrees the nuclear reactor technology. These patterns are:

1. The pattern of importation which has been followed by the countries with high financial capability.

2. The pattern of joint ventures which is developing rapidly in the countries with low financial capabilities.

3. The pattern of self-reliance which predominates Algeria's efforts in this sphere.

The Arab countries that followed either of the first two patterns have faced numerous difficulties due to the lack of trust in the atmosphere of the ongoing dialogue between the advanced and the developing countries and have, therefore, turned toward the third pattern (58).

4. Manpower and Nuclear Management:

It is evident from the preceding paragraphs that nuclear activities in the Arab homeland are shared by several government authorities in each Arab country. This has been reflected in complications in the Arab nuclear efforts (65).

It is worth noting that some of the national nuclear technologies have realized considerable progress in their management systems and have, consequently, made their corrective step toward the right action. All this has been done with the support of the progressive national circles which may include the decision makers in matters of technology, economy and politics. As a result, Algeria, Iraq and Egypt have carried out pioneer works in this regard. In Algeria, for example, the Nuclear Sciences and Technology Center was set up at the end of the 1960's to realize an effective Algerian nuclear strategy. There is no doubt that this center's high degree of independence and maneuverability has enabled it to formulate ambitious policies to acquire and employ the nuclear technology. Due to the strong care characterizing the activities of the center's various departments, encouraging results have been realized. The said center has been given 45 million Algerian dinars to realize its ambitions (67). Sonarem Company, controlled by the Ministry of Heavy Industries, helps the said center in exploring and exploiting uranium in southern Algeria (68 & 69).

It is useful to point out some of the important progressive accomplishments realized by the Algerian nuclear administration so far. It has become evident that:

A. By defining acquisition of the nuclear technology as a main duty of the Nuclear Sciences and Technology Center, Algeria has taken a practical step toward unifying a national planning department for nuclear technology research and development. As a result, Algeria will implement its first plan for the development of nuclear technology.

B. By implementing the Algerian center's policy seeking mastery of the nuclear technology, Algeria will attain by the end of the 1970's: 1 - A complete agglomeration of the industrial nuclear knowledge; 2 - An advanced step in building the nuclear fuel cycle; 3 - A bolstering of nuclear research and development effort; 4 - Extensive activities in the sphere of nuclear education and training.

C. By linking the Algerian center's technological works with the other major national technological activities, the first phase of the process of employing the Algerian nuclear technology will receive popular support and the backing of the Arab public opinion (70).

The background papers of the CASTRAB conference (71), of the third Arab conference on mineral wealth (72) and the ECWA seminar on the transfer of technology to the Arab homeland (73) contain modern data and analysis on Arab science and technology. We wish we could add a complete analysis of the situation of the manpower engaged in the Arab nuclear technology. But the difficulties of communicating with some Arab countries--difficulties emanating from the short time set for this research--have prevented providing such data and analysis. However, it must be pointed out that completing the data on the Arab scientific and technological manpower is something that must be performed in order to determine the gaps between the availability of such manpower and the demand for it at present and in the future, with special details concerning the requirements arising from doing away with foreign manpower. It is understood currently that the volume of the scientific and technological manpower engaged in the sphere of nuclear works ranges from zero percent (in Bahrain, Oman, South Yemen and Syria) to 50 percent (in Algeria, Egypt and Iraq) of the total national manpower engaged in the sphere of science and technology. The availability of complete data on this manpower can help in the future in adopting the right measures in the sphere of education, training and employment programs which must be founded on the Arab national and regional bases to guarantee the availability of the trained nuclear manpower that must be present in the future to meet the requirements of the various aspects of the Arab nuclear industry.

5. Regional International Cooperation to Develop Nuclear Technology in Arab Homeland:

Promising cooperation initiatives in the sphere of Arab science and technology in Arab be discerned in the early 1960's. Coordinating the regional and international aid programs in the sphere of science and technology and linking the Arab academic environment with Arab development were two main goals of those initiatives (74 & 75). The second goal has been reinforced by the exchange of expert activities that have begun to take their place among the Arab establishments (meaning the universities and research and technology centers). But the coordination efforts have continued to be confined to some non-nuclear scientific systems because of the administrative and political problems existing among the Arab states (76).

The establishment of the Arab Middle East Regional Isotopes Center in Cairo offers the Arab homeland the right opportunity to initiate a comprehensive operation to employ the peaceful nuclear technology. So far, the center has carried out several Arab activities, the most important of which are:

A. Conducting studies on surface waters in Egypt, Kuwait, Libya and Sudan.

B. Conducting experiments on the interrelationship between fertilizers, water, soil and plants in each of Egypt, Iraq and Sudan.

C. Providing training on some of the peaceful nuclear technologies in the Arab homeland.

D. Conducting scientific research on eradicating the fruit fly, the malaria mosquito, abnormalities of the lymph glands and bilharzia in Lebanon, Iraq, Egypt and Sudan.

Even though most of the activities entrusted to the said center are regional Arab tasks, they have been carried out under an either purely national program or under various slogans of the regional Arab concept. As a result, this center has failed to perform its duty as an Arab regional center. In any case, the center did actually realize an Arab regional accomplishment embodied in linking the national Arab activities in the sphere of the peaceful nuclear technology. The center has thus contributed to reducing the multiplicity of efforts in the same sphere of action.

The Arab governments were very slow to adopt measures to bolster the process of mastering the nuclear technology at the regional Arab level and did nothing noteworthy regarding Arab cooperation in the sphere of nuclear energy. To overcome this disappointing situation, some Arab regional financial establishments, organizations and authorities have expressed their desire to advance aid to special efforts seeking to produce a model for the Arab nuclear energy (77 & 78). Through the Arab mineral wealth conferences organized by the Arab States Industrial Development Center, the Arab homeland became aware of an early means of cooperation in exploring nuclear metals. In the first conference held in Baghdad in 1972 (79), the matter of Arab cooperation in the sphere of specialized training, in unifying the maps on mineral resources, in industrial organization and in the sphere of coordinating production, marketing and financing was brought up. In the second conference held in Jiddah, a proposal was made to adopt exploration technologies compatible with the geological conditions existing in the Arab countries. It was also pointed out that maximum efforts had to be exerted in the scientific sphere and that appropriate financing had to be invested to supply nuclear energy to the Arab countries. The latter issue was considered fundamental for enabling the Arab countries to keep up pace with the international development in the sphere of energy (80). The third conference which was held in Rabat proceeded toward:

A. Setting up the Arab Mineral Organization in Rabat with the hope that it would perform a leadership role (like that of the OAPEC) in the sphere of the mineral industries.

B. Adopting a phased strategy to develop the Arab mineral resources. Detailed reference was made in this strategy to "the presence of common elements among the Arab countries in the sphere of developing their mineral resources. The level of the exploitation of these resources varies from one Arab country to another according to the country's planning conditions and to its industrial development (81). Therefore, these factors must be taken into consideration when formulating a country's mining policy." The strategy adopted at the conference defined the minerals available in the Arab countries, including the radio-active minerals, and discussed the factors affecting this strategy, such as reserves, production, marketing, the supporting industrial structure, the environment and the non-mineral resources, training, education, development and research, financing, mineral industrialization and protection.

The march of the Arab Mining Company underlines the first practical step toward implementation of the aforementioned policy. In recent years, the said company has performed its Arab cooperation role through its participation in a number of Arab national projects (82). Its present commitments include: The Jordanian potash project, the lead project in Morocco, the copper mining project in Morocco, in addition to assessing several opportunities proposed by a number of Arab countries in the sphere of prospecting for and developing the production of uranium (83).

To enhance Arab cooperation in the sphere of nuclear technology, a good opportunity lies in the following spheres:

A. Boosting the centers and establishments concerned with any of the nuclear technology aspects by taking some effective measures that enable these establishments to develop their programs and activities on Arab regional bases (84).

B. Formulating a uniform model through which the Arab wish to acquire nuclear technology is realized (85).

C. Developing the rate of the Arab commitment participating in most aspects of the Arab nuclear industries (86). The best example that can be cited in this regard is the action taken by the OAPEC, the Arab Social and Economic Development Fund and the Kuwaiti Fund for Arab Economic Development which have cooperated on behalf of the Arab homeland to test several means through which the aforementioned goal in the sphere of natural resources and energy can be realized. In the 1977 Wisconsin seminar, financed by the three abovementioned organizations, a comprehensive analysis of the natural resources policies was made within the framework of the economic development of the developing countries. The issues of the balance of the resources, balance of the technologies, of integration of the developing countries within the international framework and the means of cooperation at the international level were also studied carefully (87). To attain effective Arab convictions in the sphere of energy (both regionally and internationally), the Arab Social and Economic Development Fund and the OAPEC developed the idea of the first Arab energy conference which was held in Abu Dhabi, the UAE, from 4-8 March 1979.

Until recently, there has been very limited international cooperation in the sphere of employing and developing nuclear technology in the Arab homeland. We can feel no tangible cooperation shown by any of the establishments or organizations concerned in the advanced countries, except for the organizations connected with the United Nations or the Soviet Union. The Soviet Union has supplied a number of Arab countries with heavy nuclear means and with sincere technological cooperation in several aspects of the nuclear technology (88). Through the U.N. projects (89), the Arab homeland has realized, for example: 1 - Establishment of the Arab Middle East Regional Isotopes Center; 2 - Nuclear technology training given to 87 scientists and technologists for a total duration of 956 months; 3 - Support by the International Atomic Agency for the projects to prospect for uranium; 4 - Participation by other U.N. organizations, such as the UNESCO, the ECWA and the U.N. programs, in the new Arab efforts seeking to plan, employ and develop the nuclear technology (90).

Results and Proposals:

This research of ours forms a pioneer exploration of the state of the Arab nuclear potential and a scientific evaluation of its progress in comparison with the prevalent international bases concerning the development of the nuclear technology. Generally, the policies and activities reviewed in our research indicate that before the 1970's the Arab homeland witnessed slow movement toward energy planning, extensive reliance on the conventional energy resources in most of the phased national plans and negligible interest in the contemporary nuclear energy issues. Afterward, some Arab countries expressed interest in the role which the nuclear energy will play in the post-oil era by conducting concerted studies on the state of their national nuclear potentials. This interest has been reflected in the following actions:

Taking into consideration nuclear energy in formulating the short-range energy models, defining major tasks through which the aforementioned models are put into action and stirring national interest in nuclear energy by way of the political, economic and technological circles.

Success in realizing the abovementioned task has created comprehensive Arab enthusiasm for nuclear energy which we can sense through a review of the facts underlined in the second half of this research and in the recommendations adopted by the Arab nation in the CASTRAB conference and in the third Arab mineral resources conference held in Rabat in 1977.

In the mid-1970's, several Arab countries displayed a serious tendency to establish parts of the nuclear technology. The progress made in translating these feelings has been reflected in modest works which we have already described in this research and this progress has led to introducing numerous nuclear projects in development plans in other Arab countries. It is hoped that more good results will be announced in the near future.

The following can be concluded from the preceding review:

1. In the sphere of prospecting for, exploiting and producing uranium, a large part of the process of employing uranium has been established as a result of the prospecting activities taking place currently in each of Algeria, Iraq, Jordan, Morocco, Sudan and Somalia. At present, there is a base for a considerable wealth of technology supporting the uranium industry. This is in addition to the emergence of a sufficient economic incentive to encourage the Arab investments to enter the field of uranium production. As for the production of uranium as a byproduct of the Arab phosphate fertilizers industry, this production is still at the verge of commercial realization. However, no Arab state has yet made the first step in this sphere. Additional efforts must be exerted to set up more independent Arab uranium industries. The degree of independence in this sphere can be enhanced through joint Arab projects in this sensitive industry, especially since the format of joint Arab projects has become widespread in less important industries. As we have already pointed out, the uranium prospecting project in Morocco needs Arab financial support that spurs its slow movement. The success of such a project can raise the Arab uranium reserves by an additional 1.5 million tons by the end of this century.

2. In the sphere of the nuclear fuel cycle, some efforts have been made regarding the start of the fuel cycle. But the technology employed in this sphere is still limited and there are still many questions that must be asked regarding the developments of these efforts at both the Arab national and regional levels. The golden chance for the Arab homeland to develop and complete an independent Arab nuclear fuel cycle does not lie in adopting more national programs in this sphere but in the endeavor to realize the following:

Unite all the financial and technological resources engaged in this part of the nuclear technology and focus their efforts on selected parts of the nuclear fuel technology.

Improve the flow of the present technology through the currently established channels and enhance the degree of joint Arab cooperation in this sphere. It seems obvious that the Algerian Nuclear Sciences and Technology Center can be a suitable site for enriching the aforementioned idea and can be transformed into an effective Arab nuclear fuel technology center.

3. In the sphere of nuclear reactor technology, the Arab homeland presently relies on one of two approaches: Either importation or various types of ventures to conduct studies on this technology, on its projects and on nuclear management. The absence of (agreement) among the higher Arab national or regional authorities responsible for developing this technology constitutes a stumbling block in the face of progress in the process of mastering the nuclear technologies. Algeria overcame this obstacle when it founded the Nuclear Sciences and Technology Center, thus becoming able to manage its reactors which will be manufactured nationally [sic] in the near future. Other Arab countries, such as Iraq and Egypt, can--after long preoccupation with purely scientific research--now march forward in the action to employ heavy nuclear technology.

4. In the sphere of nuclear manpower and management, the Arab states have been very slow in taking measures to develop their technological manpower and have been even slower in realizing comprehensive industrial reform. This has led to the continued presence of several obstacles in the face of the march of the nuclear science and technology in the Arab homeland. It seems necessary to propose that most of the Arab national and regional nuclear activities join under the control of some organizations with strong powers, such as those present in Algeria, Iraq, and Egypt, in which administrative reform and development of manpower can be realized with utter effectiveness. It is worth noting the praiseworthy and courageous role played by prominent Arab individuals in their countries' scientific and technological progress. Had it not been for the initiatives of such individuals, Morocco would not have been able to realize its expectations to realize a big uranium reserve, Algeria would not have been able to have such an outstanding center as the Nuclear Sciences and Technology Center and nuclear research and efforts in both Iraq and Egypt would not have seen the light.

5. In the sphere of peaceful nuclear technologies, the Arab countries have been given an ideal opportunity to employ several technologies in this sphere. Expansion of higher education in peaceful nuclear technology, the presentation of independent projects and the encouragement of regional cooperation can lead to creating a number of effective components for the progress and development of peaceful nuclear technologies in agriculture, irrigation, medicine and the environment. Greater attention must also be given to the Arab Middle East Regional Isotopes Center to enable it to realize more success at the national and regional levels.

6. In the sphere of regional and international cooperation, nothing noteworthy has been realized in this sphere. This disappointing situation may be the result of the secretive nature of the national nuclear projects and of the way in which such plans are implemented. However, some initiatives are underway throughout the Arab homeland to enhance Arab cooperation in the sphere of nuclear science and technology and these initiatives are supported by some Arab national and regional circles. Most of these initiatives can be generally described as recommendations, studies and the plans of the regional and international conferences already mentioned.

Despite the difficult reality under which the Arab nuclear experience is living, this experience possesses considerable Arab national and regional growth potentials. However, the degree of regional growth will remain limited and distant from absorbing the sensitive aspects of the nuclear technology in a complete manner as a result of the international tension on the one hand and of the development conditions and of the confrontation under which the Arab homeland countries are living on the other hand. At the Arab level, the potentials for the Arab nation's collective possession of a complete and independent nuclear industry seem to lie in several available opportunities, of which the most outstanding, just to name a few, are the following:

First, considering that development is the Arabs' fundamental issue and that the revenues of raw materials are the major means for realizing this development, it seems practically appropriate for the Arab nation to follow the course of exchanging a part of the revenues of these raw materials for new revenues, namely technology revenues. Foremost among these new technologies are the sensitive nuclear technologies that are needed to create a complete Arab nuclear industry that guarantees the future generation a definite alternative to oil when it is depleted.

Second, proceeding on the premise of Arab economic integration, it seems that the Arab homeland's golden opportunity to complete its nuclear industry does not lie in adopting more national nuclear programs but in the endeavor to realize the following:

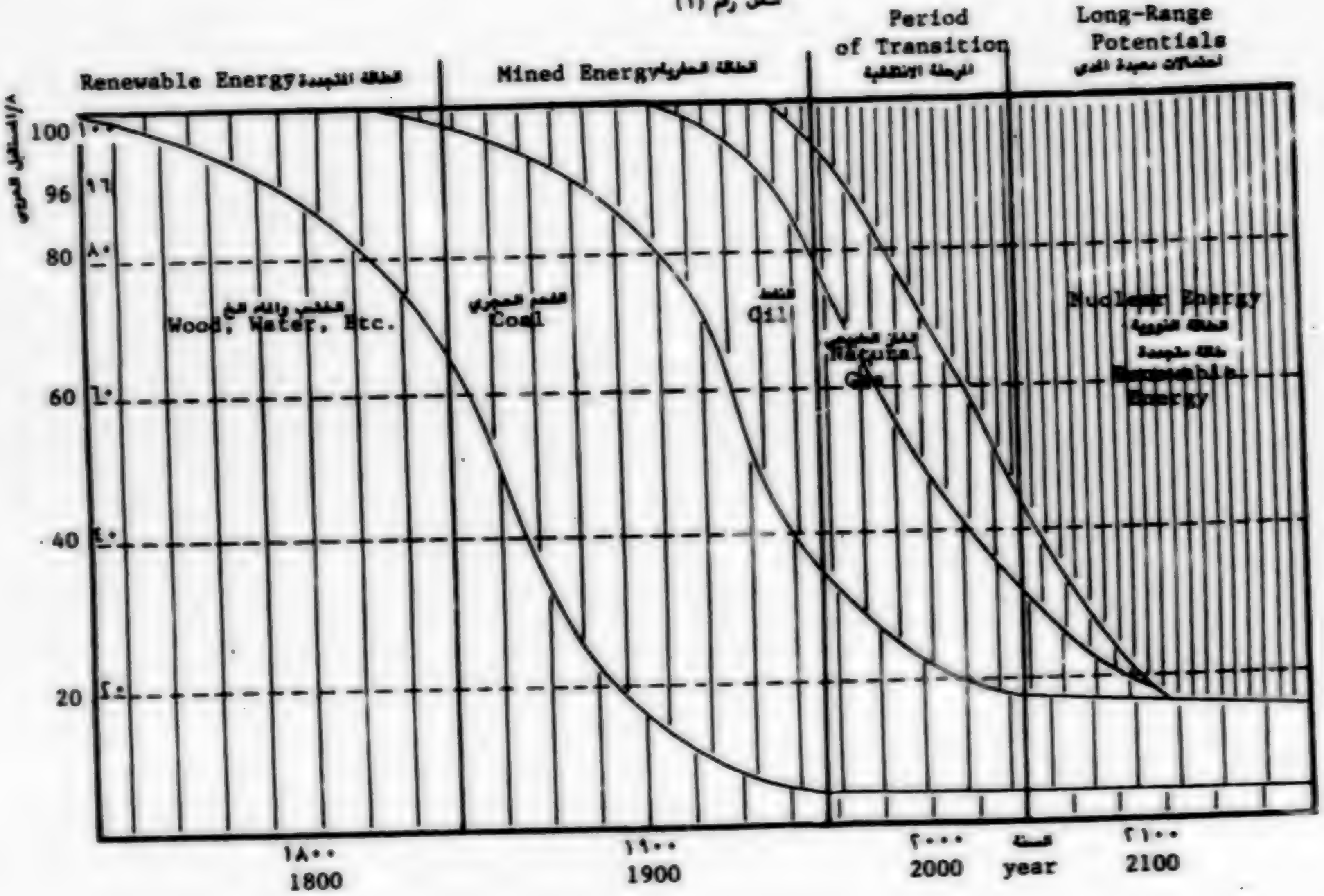
A. Adopt and nurture the successful regional experiments with various kinds of joint aid in order to develop these experiments so that they may hold a specialized position in one aspect of the nuclear technology.

B. Develop the efficiency of the current nuclear programs in the various Arab countries by providing them with effective channels for the transfer and dissemination of technology.

C. Comprehensive participation by all the Arab, regional and international funds, banks and organizations in supporting the Arab national and regional nuclear activities, considering that they have already established their participation in the other developmental activities.

[Graphs and charts on following pages]

Graph No 1
شكل رقم (١)



Graph No 2
الشكل (٢)

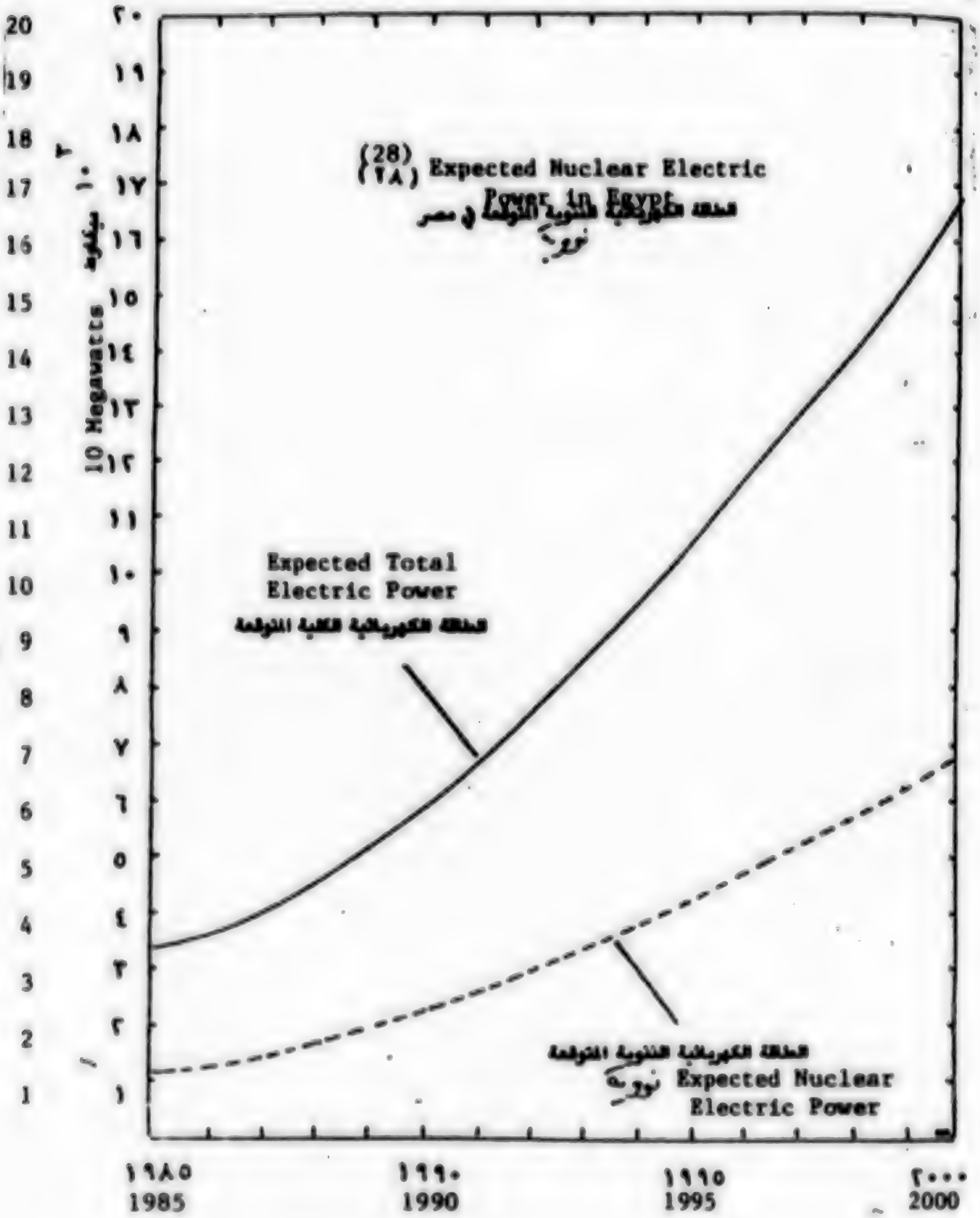


Chart No 1

Estimate of Uranium Resources in Countries Outside Socialist Bloc, Plus Yugoslavia (22), in Abridged Uranium Tons:

Production Cost Per British Pound (lb.) (U.S. Dollars in 1972)	Reasonably Certain Resources	Estimated Additional Resources
Under $10	765,000	470,000
Under $15	1,375,000	775,000
Under $30	1,760,000	1,740,000

Chart No 2

Expectations of Demand for Uranium (in Uranium Tons) (24)

Year	Annual Demand
1985	71,000- 88,000
1990	102,000-156,000
1995	134,000-234,000
2000	178,000-338,000

Chart No 3

Operational or Planned Phosphate Fertilizer Industries in Arab Homeland (27)

Country	Operational Capacity in Tons (1976)	Planned Capacity in Tons (1985)
Algeria	194,800	542,660
Bahrain	Not Available	Not Available
Egypt	100,600	208,480
Iraq	Not Available	419,500
Jordan	Not Available	472,050

Country	Operational Capacity in Tons (1976)	Planned Capacity in Tons (1985)
Kuwait	Not Available	Not Available
Lebanon	300,000	450,000 (A)
Libya	Not Available	Not Available
Mauritania	Not Available	Not Available
Morocco	396,910	291,510
Oman	Not Available	Not Available
Qatar	Not Available	Not Available
Saudi Arabia	Not Available	235,000
Sudan	Not Available	Not Available
Syria	Not Available	450,000 (B)
Tunisia	348,800	511,000
Grand Total	1,340,670	3,580,200

(A) Corrected according to official figures, 1976, Ministry of Petroleum and Industry, Lebanon.

(B) Corrected according to official figures, 1978, Ministry of Industry, Syria.

Chart No 4

Transfer and Development of Nuclear Technology

Country	Establishment	Activity	Headquarters/Cadres
Algeria	Nuclear Sciences and Technology Center	Nuclear Fuel Cycle Reactor Engineering Applied Nuclear Research Physical Health Research Training	Available/ 89 Researchers 40 Trainees 43 Technologists
	Ministry of Heavy Industry	Uranium Prospecting	Available/

Country	Establishment	Activity	Headquarters/Cadres
Bahrain	Not Available	Not Available	Not Available
Egypt	Atomic Energy Organization	Applied Nuclear Research and Training Research	Available/
	Nuclear Energy Installations Authority		Available/
Iraq	Nuclear Energy Organization	Applied and Pure Research Research on Use of Isotopes in Agriculture and Health	Available/
Jordan	Natural Resources Authority	Uranium Prospecting and Mining	Available/Few
	Jordanian University	Research and Training Reactor	Available/ Specialists Technologists
Kuwait	Nuclear Energy Commission	Has Planned for Training on and Management of Nuclear Water Desalination Projects	Not Available
Lebanon	Nuclear Research Center	Mining, Water, Resources, Agricultural & Environmental Services	Available/ Specialists Technologists
Libya	Nuclear Energy Commission (1975)	Experimental And Pure Nuclear Research	Available/ Specialists Technologists
Mauritania	Not Available	Not Available	Not available

Country	Establishment	Activity	Headquarters/Cadres
Morocco	Ministry of Energy and Minerals	Uranium Prospecting and Mining	Available/ Specialists Technologists
Oman	Not Available	Not Available	Not Available
Qatar	Not Available	Not Available	Not Available
Saudi Arabia	Ministry of Oil and Minerals	Uranium Prospecting and Mining	Available/ Specialists Technologists
	Petroleum and Minerals University	Reactor for Training Purposes	Available/ Specialists Technologists
	Riyadh University	Reactor for Training Purposes	Available/ Technologists
Somalia	Ministry of Minerals and Water Development	Uranium Prospecting and Mining	Available/ Specialists Technologists
Sudan	Ministry of Energy and Mining	Uranium Prospecting and Mining	Available/ Specialists Technologists
Syria	Ministry of Oil and Mineral Resources	Uranium Prospecting Plans	Available/ Technologists
	Atomic Energy Commission	Use of Isotopes in Medicine	Available/ Specialists Technologists
	Damascus University	Some Applications of Nuclear Technology	Available/ Specialists
Tunisia	Scientific and Technological Research	Basic Training and Research	Available/ Specialists Technologists

Country	Establishment	Activity	Headquarters/Cadres
UAE	Not Available	Not Available	Not Available
North Yemen	Not Available	Not Available	Not Available
South Yemen	Not Available	Not Available	Not Available

Sources of Data: 1-National; 2-Reference in Footnote No 14.

Chart No 5

Uranium Residues in Arab Phosphates

Country	From	To
Algeria	0.011	0.014
Egypt	0.007	0.012
Morocco	0.012	0.014
Syria	0.008	0.015
Tunisia	0.003	0.004
Jordan	0.007	0.018

Chart No 6

Uranium Metal Deposits in Arab Homeland
(Estimated in 1,000 Abridged Tons of Uranium Oxide)

Country	Type of Deposit	Reasonably Certain Reserve	Estimated Additional Reserve
Algeria	Primary	25.0	25.0
	Secondary (1972)	35.1	50.0
Egypt	Primary [byproduct]	1.2	2.4
	Secondary	232.5	Not Available

Country	Type of Deposit	Reasonably Certain Reserve	Estimated Additional Reserve
Iraq	Primary	Not Available	Not Available
	Secondary	176.0	Not Available
Jordan	Primary	Not Available	Not Available
	Secondary	106.0	Not Available
Mauritania	Primary	Not Available	Not Available
	Secondary	Not Available	Not Available
Morocco	Primary	46.6	1,540.0
	Secondary	4,000.0	Not Available
Saudi Arabia	Primary	Not Available	Not Available
	Secondary	91.2	Not Available
Somalia	Primary	5.5	6.3
	Secondary	Not Available	Not Available
Sudan	Primary	Not Available	Not Available
	Secondary	Not Available	Not Available
Syria	Primary	Not Available	Not Available
	Secondary	86.0	Not Available
Tunisia	Primary	Not Available	Not Available
	Secondary	88.5	Not Available
Total	Primary	78.4	1,573.7
	Secondary (52)	4,915.3	50.0

Chart No 7

Estimated Arab and International Uranium Resources Assessed in 1,000 abridged Tons of Uranium Oxide

Sector	Type of Deposit	Reasonably Certain Reserve	Estimated Additional Reserve
Arab Homeland	Primary	78.4	1,573.7
	Secondary	4,915.3	50.0
Rest of World (53)	Primary	1,130.0	1,010.0
	Secondary	8,585.0	820.0

Sector	Type of Deposit	Reasonably Certain Reserve	Estimated Additional Reserve
Ratio of Estimated Arab Resources to (Estimated) International Resources	Primary Secondary	6.9% 57.3%	156% 6%

Chart No 8

Phosphate Deposits and Production in Arab Homeland (in Million Tons) (54)

Country	Reasonably Certain Reserve (1975)	Estimated Additional Reserve (1976)	Percentage of Uranium Oxide
Algeria	642	0.8	0.011-0.014%
Egypt	3,325	0.6	0.007-0.012%
Iraq	1,760	Not Available	Not Available
Jordan	1,062	1.6	0.007-0.018
Morocco	40,000	19.3	0.012-0.014%
Western Sahara	3,000	2.4	Not Available
Saudi Arabia	Not Available	Not Available	Not Available
Syria	860	0.4	0.007-0.015
Tunisia	885	4.0	0.006-0.009
Total	52,446	29.1	
Percentage to World Total	40.3 (130,000)	26.3 (110.5)	

[Chart No 9 on following page]

Chart No 9

Operational, Announced, Requested and Planned Nuclear Reactors in Arab Homeland

Country	Type of Reactor	Capacity (in Megawatts)	Status	Year	Source	Location
Algeria (59)			Concerted Employment of Reactor Technology Through Which Algerian Nuclear Reactor Can Be Built			
Egypt (60)	Research	2	Operating	1961	Russia	Inshas
	Research	3	Announced	1980	Russia	Inshas
	Light Water		Planned	1983	U.S.	Sidi Karir
	Light Water	600	Planned	1985		
	Light Water	600	Planned	1989		
	Light Water	600	Planned	1990		
	Light Water	600	Planned	1991		
	Light Water	600	Planned	1993		
	Heavy Water	1,000	Planned	1995		
	Heavy Water	1,000	Planned	1997		
	Heavy Water	1,000	Planned	1999		
	Total	6,605		2000		

Country	Type of Reactor	Capacity (in Megawatts)	Status	Year	Source	Location
Iraq (61)	Research	Not Available	Operating	1968	Russia	
	(Ozoris)	70	Planned	1980	France	
	Ozoris	600	Agreed Upon	1975	France	
	(Rapid Generation)	Not Available	Agreed Upon	1975	France	
Kuwait (62)	Research	50	Purchased	N/A	N/A	
	N/A	3,600	Planned	2000	N/A	
Libya	N/A	400	Agreed Upon		Russia	N/A
	N/A	660	Agreed Upon		France	N/A
	Heavy Water Reactor Is Under Construction					
Morocco (63)	Uranium Will Be Exploited in 1980's					
Saudi Arabia (64)	Research	6	Under Negotiation	1977	France	Dhahran
	No Thought Given to Big Reactors Before Year 2000					
Tunisia	N/A	50	Planned	1980's		(Qabis)

NB: N/A for Not Available.

FOOTNOTES

1. This research was originally presented to the first Arab energy conference, Abu Dhabi, 4-8 March 1979. The author has rewritten it for AL-MUSTAQBAL AL-'ARABI which published it here for the first time.

2. The World Bank, Report (no Ec.-166/76).

3. More than nine tenths the current scientific research, for example, is conducted in the advanced countries which contain only one third the world population.

4. Iran Conference on Transfer of Technology, 10-14 April 1977.

5. M.A. Khan, "Comments in Round Table 7 on Nuclear Power and Its Fuel Cycle," Salzburg, 2-13 May 1977 (IAEA).

6. B.Goldschmidt, "International Cooperation in the Nuclear Field-Past, Present and Prospects," IAEA Bulletin, no 20 (1978), pp 13-24.

7. Same reference as above.

8. U.S. response to this action was to impose additional restrictions on enriched Uranium shipments.

9. August 1978, However, there were only five advanced countries possessing nuclear plants producing altogether 2 Gwe [as published]. This represents only one percent of the electric energy of the advanced countries and two percnet of the world nuclear energy. (Lane et. al., "Nuclear Power in Developing Countries," (IAEF-CN 36/50, 1977).

10. A.M. Mustafa, "Impediments to the Technological Development of the Petroleum and Mineral Resources Sector in the Arab World," in A.B. Zahlan (ed,) Technology Transfer and Change in the Arab World: A Seminar of the United Nations Economic Commission for Western Asia (Oxford: Published for the United Nations by Pergamon Press, 1978), pp 433-450.

11. Salzburg International Conference, Nuclear Power and Its Fuel Cycle, 1977, Technological Session 7:3 (IAEA, 1977), pp 481-644.

12. Such As Algeria, Egypt, Iraq and Libya.

13. A. Bennini, Private Communications (Algeria: CSTN, 1978).

14. Number if scientists and engineers in Arab world is 800 per 100,000 persons compared to 100 for Latin America and 2.875 for the advanced countries. The number of technologists in the Arab world is 150 per 100,000 persons whereas it amounts to 1,475 in Latin America and 4,800 in the advanced countries. (ECWA, 1977, E/ECWA/NR/Sem. 1/13)

15. B. Wynne, "The Politics of Nuclear Safety," New Scientists, no 77 (1978), pp 208-211.

16. F. Barnaby, "Thirty Years of Nuclear Weaponry," New Scientists, no 67 (1975), pp 330-332.

17. A.M. Cisse, "Transfer of Nuclear Technology to the Developing Countries," IAEA Bulletin, No 19 (1977), pp 9-11.

18. I.B. Hazzaa, Activity of the Middle Eastern Regional Radio-Isotope Centre for Arab Countries: Peaceful Uses of Atomic Energy in Africa (IAEA, 1970), pp 500-520.

19. Member states of the aforementioned center are: Algeria, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Sudan, Syria, Tunisia and North Yemen.

20. "Uranium Resources, Production, and Demand," NEA (OECD)/IAEA Report, 1977.

21. E. Zebroski and M. Levenson, "The Nuclear Fuel Cycle," Annual Review of Energy, no 1,11005 (1976), pp 101-130.

22. M. Considine (ed), Energy Technology Handbook (1978), part 5: Uranium Resources and Processing, by L.W. Vermueulen, pp 173-181.

23. See ref 1, chapter 2, 23. [as published in English].

24. "Uranium Supply and Demand," IAEA Bulletin, No 20 (1978), pp 24-34.

25. T.K.S. Murthy, B.N. Pai, and B.A. Nagle, "The Study of Some Phenyl Phosphoric Acids for Extraction of Uranium from Phosphoric Acid," IAEA's Symposium on the Recovery of Uranium, Sao Paulo, 17-21 August 1970, pp 341-350.

26. F. Maayouf, "The Chemical Fertilizer Industry in the Arab World," Arab Oil and Cooperation, no 4 (1978), pp 51-60.

27. Same as above reference.

28. Algerian National Liberation Front, The National Declaration-Degree [sic] no 76 (July 1976), pp 243-264.

29. M.A. Elkoshairy et al., "Possibilities of Introducing and Integrating Nuclear Power in the Egyptian Power System," Proceedings of U.N. Conference on Peaceful Uses of Atomic Energy, Geneva, 1971, pp 1-241.

30. K.E.A. Effact et al., "Future of Fuel Cycle Requirements and Radio-Active Waste Management for Egypt's Power Programme," in IAEA's Nuclear Power and its Fuel Cycle, 6, 1977, pp 178-192.

31. Ahmad Zaoui, Private Communications (Algeria: 1978).

32. J. Porera, "The Nuclear Industry, Where Do We Go From Here?" The Middle East, no 34 (1977), pp 20-33.

33. See reference No 18.

34. Akio Nomura, "Changes in World Economic Structure and Multinational Cooperation as Related to Development Strategy in Developing Countries," Chemical Economy and Engineering Review, no 8 (1976) pp 7-13.

35. Same as above.

36. The London Nuclear Club was formed in the summer of 1975 by the United Kingdom, the United States, the Soviet Union, France, West Germany, Canada and Japan.

37. President Carter announced [the development of] a tactical nuclear bomb that kills troops with its radiation but doesn't destroy buildings and installations because of its low explosive power. On 25 April 1978, President Brezhnev told the Communist Youth Conference in Moscow that Russia will not produce the neutron bomb if the Americans refrain from producing it. Earlier Carter had declared: "I have changed my mind. I believe..."

38. Israel has stolen a shipment of U.S. nuclear fuel under mysterious circumstances.

39. A high-level Italian delegate to the 1977 Salzburg Conference expressed the European reaction by saying: "To the European, avoiding retreatment seems like telling a citizen of the third world that he should not eat sugar because it is fattening."

40. See supplement No 1 in reference No 21.

41. ECWA, NRST Division, "The Status of Science and Technology in the Western Asia Region," in Seminar on Transfer of Technology and Change in the Arab Middle East, Beirut, 10-14 October 1977, pp 3-5.

42. See reference 10.

43. "Science and Technology in the Development of the Arab States," UNESCO Publications, no 41 (1977).

44. It has been estimated in these plans that the Arab demand for electric energy will rise from 7,000 mw [presumably megawatts] in 1975 to 30,000 mw in the 1990's and to 85,000 mw by the year 2000. (IDCAS July 1976).

45. The funds required to finance the finds already discovered are also enormous. It has been estimated, for example, that uranium prospecting will require 20 billion dollars by the year 2000.

46. See Supplement (B) in reference No 1 [sic].

47. A. Marcel, Etude d'Orientation du Gisement d'Uranium de Wafagga (Rabat: Bureau de Recherchet et de Participations Miniers, 1978).

48. R. Bouchta, Private Communications (Rabat: Bureau de Recherchet et de Participations Miniers, 1978).

49. I. Kamel and M. I. El Khouli, "Development and Utilization of Phosphate in Arab States," Le Development Industriel Arabe, no 30 (1977), pp 55-65.

50. Same reference as above. A.M. Mustafa, "Prospects of Radio-Active Materials in the Arab World," No 2 (1976), pp 13-26.

51. See Chart No 1 in source [indistinct].

52. Estimates of secondary uranium residues based on residues in Arab phosphate containing 0.01 connection with uranium [sic].

53. See reference No 22, pp 5-181.

54. The Arab Conference for Mineral Resources, 3rd, Ravat, 18-20 April 1977, Background Papers.

55. The Recovery of Uranium, Session VII, Sao Paulo, 17-21 August 1970, Symposium Proceedings (IAEA, 1971) pp 333-477.

56. Kamal Effat, "Interview-2," The Middle East, no 34, (1977), p 33.

57. Morocco. Hassan II, "Press Interview," Al-Alam (Morocco), 21 April 1977.

58. See reference No 10.

59. A. Bennini, Private Communications (Algeria: CSTN, 1978).

60. K.E.A. Effat et al., "Future Fuel Cycle Requirements and Radio-Active Waste Management Plans for Egypt's Nuclear Power Programme," in Nuclear Power in its Fuel Cycle, 6, 1977, pp 178-192.

61. See reference No 32.

62. Z. Abu-Eid, "Interview-1," The Middle East, no 43, (1977) pp 31-32.

63. See reference No 57.

64. F. Kabbani, "Interview-3," The Middle East, no 34, (1977) p 33.

65. See reference No 41.

66. See reference No 1.

67. See reference No 59.

68. I. Bou-Jmai'a, Private Communications (Algeria: CSTN, 1978).

69. Bodouhene and Amroua'i, Private Communications (Algeria: Sonarem, 1978).

70. See reference No 31.

71. See reference No 43.

72. See reference No 54.

73. A.B. Zahlan (ed), Technology Transfer and Change in the Arab World: A Seminar of the United Nations Economic Commission for Western Asia (Oxfored: Published for the United Nations by Pergamon Press, 1978).

74. Same as above.

75. See reference No 10.

76. Studies on barren and dry lands, solar energy and construction and industrial research, for example.

77. OAPEC, The Arab Fund for Economic and Social Development and Kuwait Fund for Arab Economic Development.

78. Y. Sayegh, "Arab Development: Achievements, Issues, Expectations," ARAB OIL AND COOPERATION 1, 65 (1975).

79. Arab Conference for Mineral Resources, 1st, Baghdad, 17-23 February 1972, Follow up of the Implementation of the Recommendations of the 1st Arab Conference for Mineral Resources (IDCAS, 1974).

80. Arab Conference for Mineral Resources, 2nd, 2-8 Nobember 1974, Nuclear Minerals and Their Role in the Arab Countries, Background Papers (IDCAS, 1974), pp 37-42.

81. See reference No 10.

82. The Arab Mining Company is a joint Arab project set up by the Arab league in 1974 on a recommendation made by the first Arab conference on mineral resources with a capital of 100 million Kuwaiti dinars.

83. Thabet Al-Taher, Private Communication. (Amman: Arab Mining Company, 1978).

84. The Arab Middle East Regional Isotopes Center in Cairo and Engineering Industries Organization in Baghdad need such a booster.

85. The Rabat Conference (CASTARAB-1977) and the resolutions of the third Arab conference on mineral resources expressed the Arab desire to a acquire nuclear energy.

86. It is possible for the Arab Mining Company and a fund for mining the discoveries in the Arab countries can form a joint project capable of dealing with such a goal.

87. The seminar on the national resources policy and its relationship with economic development and international cooperation was held at the Environmental Studies Organization in Wisconsin University, Madison, U.S.A.

88. For example, reactors for Egypt and Ira, training of nuclear technologists, nuclear equipment and prospecting for uranium in Syria.

89. Unesco's Activities in the Field of Science and Technology in the Arab World (SC-78 CONF. 232-COL. 8) (U.N., 1978).

90. U.N., World Plan of Action for the Application of Science and Technology to Development, ST/ECWA/146/REV. 1) (U.N., 1971).

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